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Study on reed-periphyton in Lake Velence

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Abstract - In this paper we give an account of our findings between 1978 and 1988, while measuring the trends and tendencies of water quality due to the rehabilitation of Lake Velence. Dry mass and phytotecton analyses of reed-periphyton collected in 1978 and 1988 are presented. With 5 tables, 1 figure and 2 photoplates.

INTRODUCTION

To determine the quality of shallow water bodies, besides the studies on water chemistry and phytoplankton, it is necessary and essential to investigate the benthonic complexum - i. e. the aquatic plants and their periphyton - and reveal its role in them. It is especially true in our shallow water bodies, where the study on aquatic plants and periphyton should deserve more attention.

Nowadays the most common danger to our waters is eutrophication. This phenomenon can be defined as a biological response to increased trophity, which causes over proliferation of plants. In order to reveal the direction and intensity of changes due to eutrophication or the processes of rehabilitation, it is necessary to evaluate the original state and the prevailing conditions from several aspects of biology.

SAMPLING SITES AND METHODS

The periphyton samples from green and old reed were taken at the open water side of reed stands (Fig. 1) in some characteristic water areas of Lake Velence from 1978. The classification of water areas of the lake follows the descriptions of BARTHA (1977), FELFÖLDY (1972) and LAKATOS (1986):

a – Dark brown water area: Vendel-tisztás (Ve), Nagytó-Rigya (Na), Gallér (Ga), Vaskapu (V), Hollós-tisztás (Ho)
b – Grey water area: Nagy-tisztás (Nt), Felső-tó (Fe), Nádas-tó (N), Belső-tisztás (B)
c – Algal brown water area: Öreg-tisztás (Ö), Kárászos (K)
d – Green water area: Fürdető (Fü)
e – Transitional water quality area: Hosszú-tisztás (Ht), Lángi-tisztás (L)

In addition, reed periphyton samples were collected from Német-tisztás (Né), which belongs to the brown water area.

During our reed-periphyton sampling water depth and transparency were measured, and water samples were taken for chemical analysis. The wet and dry mass, the ash and chlorophyll-a contents were determined. The phyto- and zootecton samples were taxonomically, qualitatively and quantitatively analysed.

RESULTS AND DISCUSSION

The structure of periphyton, its dry mass abiotic and biotic components have been studied by several authors (LAKATOS et al. 1982; PIECZYNSKA 1979; SLADECKOVA 1966). The different inorganic and organic categories were constructed on the basis of earlier results of the chemical structure of periphyton and so it was possible to separate the autotrophic and heterotrophic periphyton. These "non taxonomic parameters" can be used to study the changes in the state of water quality of water bodies.

The dry mass of periphyton collected from green and old reed varied between the following end values (Table 1).

Fig. 1. Map of Lake Velence. For abbreviations see in the text.

Table 1. Dry mass of peryphyton collected from green and old reed

	green reed periphyton d. m. reed sterm m^{-2}	old reed periphyton d. m. reed sterm m^{-2}
1978 min.	6.0 Fü	27.6 Fü
max.	89.2 Ht	156.8 Ht
mean	30.1±24	86.8±46
1988 min.	12.1 Ve	25.2 K
max.	77.9 Ht	136.5 Na
mean	29.9±19	59.0±34

The data in the above table reflect the change in the dry mass of periphyton collected in Fürdető, but the subsequent one gives more information about the trends of periphyton-dry mass:

dry mass of periphyton increased: green reed: L, Ho, Ö, K, Fü, old reed: Fü; it remained constant: green reed: Nt, Ht, old reed: Na, Nt, N, Ö; it decreased: green reed: V, Vt, Na, Ga, Fe, N, B, old reed: V, Vt, L, Ga, Ho, Fe, B, K, Ht.

The dry mass of periphyton taken in the algal brown water areas increased while the same in the dark brown water areas decreased. The decrease is more conspicuous in the case of periphyton collected in Felső-tó and Hosszú-tisztás, in areas which belonged to the category of large mass periphyton. Based on the dry mass of periphyton collected from green reed in the study years, the subsequent categories can be established. The increased dry mass of periphyton (e.g. Fü, L) can be explained by the larger ash content, i. e. the higher ratio of inorganic components.

Small mass periphyton categorised as organic-inorganic, -characteristic of 1978, prevails (in this category which was taken only from Német-tisztás). Besides inorganic deposits, the increase in non-chlorophyll organic contents is significant and thereby the reed-periphyton can be classified as heterotrophic.

After evaluating and discussing the data resulting from non-taxonomical investigations, some more important data of the phytotecton algological analysis are presented (the list of taxa in 1988 is presented in Table 5, that of 1978 is seen in LAKATOS & BARTHA 1989).

Percentual distribution of phyla in the phytotecton in Lake Velence is presented in the Table 2.

The identified number of taxa in both years are almost identical, some percentual increase is characteristic only of the diatom composition of the phytotecton. The algological picture is more interesting, when the results of phytotecton analysis of samples collected in the three characteristic water areas are compared.

The percentual distribution of algal phyla in the phytotecton samples taken from green reed in Vendel-tisztás, Nagy-tisztás and Fürdető is presented in Table 3.

The number of identified alga taxa in the phytotecton samples taken from the green reed in Vendel-tisztás belonging to the brown water areas, shows a significant decrease, more than 35 %. Cyanophyta and Euglenophyta were not found at all, the composition of diatom species was significantly altered, and the phytotecton also became less diverse in the other spots of the brown water areas. In the case of Nagytisztás belonging to the grey water area, changes in the composition of phytotecton were less significant, although the increase in the number of diatom species and the decrease in Chlorophyta species are worth mentioning. The most important change took place in Fürdető (it is a green water area), where high individual number of composition of phytotecton was recorded with a large number of diatom species which contrasted the previous low number. Before dealing with the alteration of algal species and the redistribution of the phytotecton structure in detail, Table 4 is shown.

Our table illustrates that the small-size *Achnanthes minutissima* became a more dominant species, especially in Vendel-tisztás and Fürdető. The number of *Navicula* genus significantly decreased in the periphyton of each open space. The individual number of *Nitzschia linearis* being a good indicator of the organic pollution of the water (EVENSON et al. 1981, RUSHFORTH et al. 1981), decreased to 1 % from its earlier 50 % in Fürdető, but *Cymbella lacustris* and *Fragilaria capucina* var. *vaucheriae* appeared in high individual number, instead.

The individual number of *Rhoicosphenia abbreviata*, a gelatinous shafted alga, decreased in the samples from Nagytisztás. The same tendency was observed for the large-sized *Fragilaria ulna*, with the exception of Fürdető, where no such species was identified earlier and its present proportion of the total individual number of diatoms is only about 1 %.

The phytotecton analysis suggests a significant alteration in the structure of species and the dry mass. The phytotecton collected from the brown water areas became more uniform and monotone, and the same from the grey water areas altered only little. The change in the structure of phytotecton is advantageous at Fürdető (green water area), where the water was planktonically eutrophized in 1978. The change of phytotecton composition is in accordance with the results of water chemistry and plankton studies showing an improvement in water quality and underline the processes of oligotrophication.

The change in the composition of zootecton is less distinct, because zootecton responds to the alteration of plankton and phytotecton with delay, therefore the zootecton collected in Fürdető and the nearby Kárászos and Öreg-tisztás can at present be classified as Phylactolaemata-Bdelloidea-Heteroptera-type.

The role of bryozoons, in the food cycle, owing to their alimentation, is worthy of mention (Job 1976, Lakatos & Bartha 1989, Meschkat 1934, Sebestyén 1952).

In the brown, grey and transitional water areas of the Lake Velence, the zootecton can even today be still described as Rhabditidea-Cladocera-Trichoptera community. In hairy, rich in mud periphyton, the nematodes and diatoms (e.g. *Cymbella*) live together, where cladocerans and caseless caddisfly larvae also find hiding place and resources of food.

SUMMARY

The results of the studies on periphyton carried out in 1978 and 1988 in Lake Velence indicate the changes in water quality occurring under the influence of lake restoration and provide opportunities to forecast the probable tendencies. As a result of dredging the reed stands and bank arrangements the separated water surfaces disappeared and became uniform. Thus, the special mosaic-like nature of the lake due to the hydrobiological properties has practically come to an end (except for the black-brown water of the small open spaces of the preserves). The decrease in the number of phytotecton species, and the repression and disappearance of weed, in other words, the change in the composition of living organisms in the brown water areas, is quite obvious.

The larger, open water surfaces, on the one hand, are practical for holidaymaking, on the other hand, they contribute to the mixing of water which in turn becomes more homogenous continuously solving certain local problems (e. g. planktonic eutrophication). These advantageous changes in water quality in Fürdető and in its surrounding are revealed by the structural changes in phytotecton.

In summing up we can confirm that conscious human intervention in Lake Velence, although it has altered the earlier mosaic-like structure of the lake and thereby decreased its hydrobiological diversity and natural values, it much contributes to a better water quality, a general demand of the public.

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Table 5.a. List of algal taxa

Taxa	green reed	old reed
CYANOPHYTA		
Aphanocapsa grevillei (HASS.) RABENH.	+	+
Chroococcus minutus (KÜTZ.) NÄG.	+	+
Gomphosphaeria lacustris CHODAT	+	+
Lyngbya limnetica LEMM.	+	+
Lyngbya sp.		+
Merismopedia glauca (EHRBG.) NÄG.	+	+
Microcystis aeruginosa KÜTZ.	+	+
Nostoc sp.	+	+
Oscillatoria sp.	+	+
Spirulina subsalsa OERST.		+
EUGLENOPHYTA		
Euglena polymorpha DANG.	+	+
Phacus sp. I.		+
Phacus sp. II.		+
CHRYSOPHYTA, Xanthophyceae		
Goniochloris fallax FOTT	+	+
G. mutica (A. BRAUN) FOTT	+	
CHRYSOPHYTA, Bacillariophyceae		
Achnanthes minutissima KÜTZ.	+	+
Amphora coffeaeformis (AG.) KÜTZ.	+	
A. ovalis (KÜTZ.) KÜTZ.		
Attheya zachariasi J. BRUN.	+	
C. schumanniana (GRUN.) CLEVE		+
C. silesiaca BLEISCH	+	+
Caloneis amphisbaena (BORY) CLEVE	+	+
Campylodiscus clypeus EHR.	+	+
Centrales sp.	+	+
Chaetoceros muelleri LEMM.	+	
Cocconeis placentula EHR.	+	+
Cyclostephanos dubius (FRICKE) ROUND	+	+
Cyclotella atomus HUST.	+	
C. cryptica (REI.) LEW. et GUILL.		+
C. meneghiniana KÜTZ.	+	+
C. pseudostelligera HUST	+	
Cymbella affinis KÜTZ.	+	+
C. aspera (EHR.) CLEVE	+	+
C. cistula (EHR.) KIRCHN.	+	
C. elginensis KRAMMER	+	+
C. lacustris (AG.) CLEVE	+	+
C. laevis NÄG.	+	+
C. lanceolata (EHR.) KIRCH.	+	+
Cymbella sp.	+	

Table 5.b. List of algal taxa

Taxa	green reed	old reed
Diatoma elongatum AG.	+	+
D. hiemale (LYNGB.) HEIBERG	+	
Diploneis sp.	+	
Entomoneis alata (EHR.) EHR.	+	+
Epithemia adnata (KÜTZ.) BRÉB.	+	+
E. sorex KÜTZ.		+
Fragilaria capucina DESM.		+
F. capucina var. *vaucheriae* (KÜTZ.) LANGE-BERT.	+	+
F. construens (EHR.) GRUN.	+	+
F. fasciculata (AG.) LANGE-BERT.	+	+
F. ulna (NITZSCH.) LANGE-BERT.	+	+
F. ulna var. *acus* (KÜTZ.) LANGE-BERT.	+	+
G. angustatum (KÜTZ.) RABEN.	+	+
Gomphonema angustum AG.		+
G. olivaceum (HORNEMANN) BRÉB.	+	+
G. olivaceum var. *calcareum* (CLEVE) CLEVE	+	+
G. ventricosum GREGORY		+
Gyrosigma acuminatum (KÜTZ.) RABENH.	+	+
Mastogloia smithii THWAITES	+	
Melosira granulata (EHR.) RALFS	+	
M. granulata var. *angustissima* MÜLL.	+	
M. italica (EHR.) KÜTZ.	+	
Navicula capitata var. *hungarica* (GRUN.) ROSS	+	+
N. cryptocephala KÜTZ.	+	+
N. cuspidata (KÜTZ.) KÜTZ.		+
N. digitoradiata (GREGORY) RALFS	+	+
N. gregaria DONKIN		+
N. lanceolata (AG.) EHR.	+	+
N. menisculus SCHUMANN	+	+
N. oblonga KÜTZ.	+	+
N. obsoleta HUST.	+	+
N. placentula (EHR.) GRUN.	+	+
N. pupula KÜTZ.		+
N. tripunctata (D. F. MÜLLER) BORY		+
Nitzschia acicularis W. SMITH	+	+
N. angustata (W. SMITH) GRUN.	+	+
N. hungarica GRUN.	+	+
N. linearis W. SMITH	+	+
N. palea (KÜTZ.) W. SMITH	+	+
Nitzschia sp. I.	+	+
Nitzschia sp. II.	+	+
Nitzschia sp. III.	+	+
Nitzschia sp. IV.		+
Ophiocytium capitatum WOLLE	+	
Rhoicosphaenia abbreviata (C. AG.) LANGE-BERT.	+	+
Rhopalodia gibba (EHR.) O. MÜLLER	+	+

Table 5.c. List of algal taxa

Taxa	green reed	old reed
Stephanodiscus parvus HAK. et ST.		+
Surirella elegans EHR.	+	
S. ovalis BRÉB.	+	+
Thalassiosira pseudonana HASLE et HEIMDAL		
PYRROPHYTA, Cryptophyceae		
Cryptomonas erosa EHR.	+	+
PYRROPHYTA, Peridineae		
Peridinium hiemale SCHILLER		+
CHLOROPHYTA		
Coelastrum microporum NÄG. in A. BR.	+	+
C. sphaericum NÄG.		+
Cosmarium granatum BRÉB.	+	
C. laeve RABENH.	+	
C. laeve var. *westii* KRIEG. et GERL.		+
C. polygonatum HALÁSZ	+	+
C. tenue Arch. W. WEST	+	+
C. trilobulatum REINSCH. W. WEST	+	+
Crucigenia quadrata MORR.	+	+
C. tetrapedia (KIRCHN.) W. et G. S. WEST	+	+
Kirchneriella lunaris (KIRCH.) MOEB.		+
K. obesa (W. WEST) SCHMID.	+	+
Lagerheimia citriformis (SNOW) COLL.		+
Lagerheimia subsalsa LEMM.	+	+
Monoraphidium griffithii (BERK.) KOM.-LEGN.	+	+
Mougeotia sp.	+	+
Oocystis lacustris CHOD.	+	+
O. solitaria WITTR. in WITTR. et NORDST.	+	+
Oocystis sp.	+	+
Pediastrum boryanum (TURP.) MENEGH.	+	+
P. boryanum var. *cornutum* (RACIB.) SULEK	+	+
P. tetras (EHR.) RALFS	+	
Risoclonium hieroglyphicum (C. A. AG.) KÜTZ.	+	+
Scenedesmus acuminatus (LAGERH.) CHOD.	+	+
S. ecornis (EHR.) CHOD.	+	+
S. opoliensis P. RICHT.	+	+
S. quadricauda (TURP.) BRÉB.	+	+
Spirogyra sp.	+	+
Staurastrum cingulum (W. & G. S. WEST) G. M. SM.		+
S. tetracerum (KÜTZ.) RALFS	+	
Tetraedron caudatum (CORDA) HANSG.	+	+
T. minimum (A. BR.) HANSG.	+	+
T. minimum var. *apiculatum* REINSCH	+	
Tetrastrum glabrum (ROLL) AHLSTR. et TIFF.		+
T. staurogenieforme (SCHRÖD.) LEMM.		+

Table 2. Percentage distribution of phyla in phytotecton in Lake Velence

Phyla	1978		1988	
	green (%)	old (%)	green (%)	old (%)
Cyanophyta	7.8	7.0	7.8	9.7
Euglenophyta	2.0	2.0	1.0	2.9
Chrysophyta	56.9	56.0	62.8	54.4
Pyrrophyta	1.0	0.0	1.0	1.9
Chlorophyta	32.3	35.0	27.4	31.1

Table 3. Percentage distribution of algal phyla in the phytotecton samples taken from green reed in Vendel-tisztás, Nagytisztás and Fürdető

Phyla	1978 (%)			1988 (%)		
	Ve	Nt	Fü	Ve	Nt	Fü
Cyanophyta	4.9	3.6	0.0	0.0	2.9	5.1
Euglenophyta	3.3	0.0	13.3	0.0	2.9	2.6
Chrysophyta	68.9	60.7	40.0	69.2	76.6	79.5
Pyrrophyta	0.0	0.0	0.0	2.6	2.9	0.0
Chlorophyta	22.9	35.7	46.7	28.2	14.7	12.8

Table 4. The percentage of dominant diatoms in the periphyton collected from green and old reed in three characteristic parts of Lake Velence

	1978					
	green (%)			old (%)		
	Ve	Nt	Fü	Ve	Nt	Fü
Achnanthes minutissima	1.6	.0	23.2	14.1	2.4	22.8
Cocconeis placentula	1.8	1.7	.0	1.1	3.5	.0
Navicula cryptocephala	13.8	5.8	.0	16.7	12.4	5.5
N. obsoleta	8.6	12.5	19.2	20.1	10.1	14.6
Nitzschia linearis	.3	.0	50.4	0.8	.0	41.1
Rhoicosphenia abbreviata	12.3	49.4	2.6	8.8	6.5	2.8
Fragilaria ulna	23.3	1.3	0.0	10.3	13.0	.0
other diatoms	28.3	29.3	4.6	28.1	52.1	13.2

	1988					
	green (%)			old (%)		
	Ve	Nt	Fü	Ve	Nt	Fü
Achnanthes minutissima	68.5	22.0	62.8	60.8	13.2	22.8
Cocconeis placentula	1.9	1.2	.2	4.9	8.2	11.5
Navicula cryptocephala	1.4	1.2	1.3	1.2	2.1	6.0
N. obsoleta	.0	1.2	1.0	.0	.0	.0
Nitzschia linearis	.0	4.6	.5	.0	1.3	1.1
Rhoicosphenia abbreviata	1.9	.0	1.3	7.0	7.6	12.6
Fragilaria ulna	.9	1.2	.8	.6	7.6	1.5
other diatoms	25.4	68.5	32.1	25.5	60.0	44.5

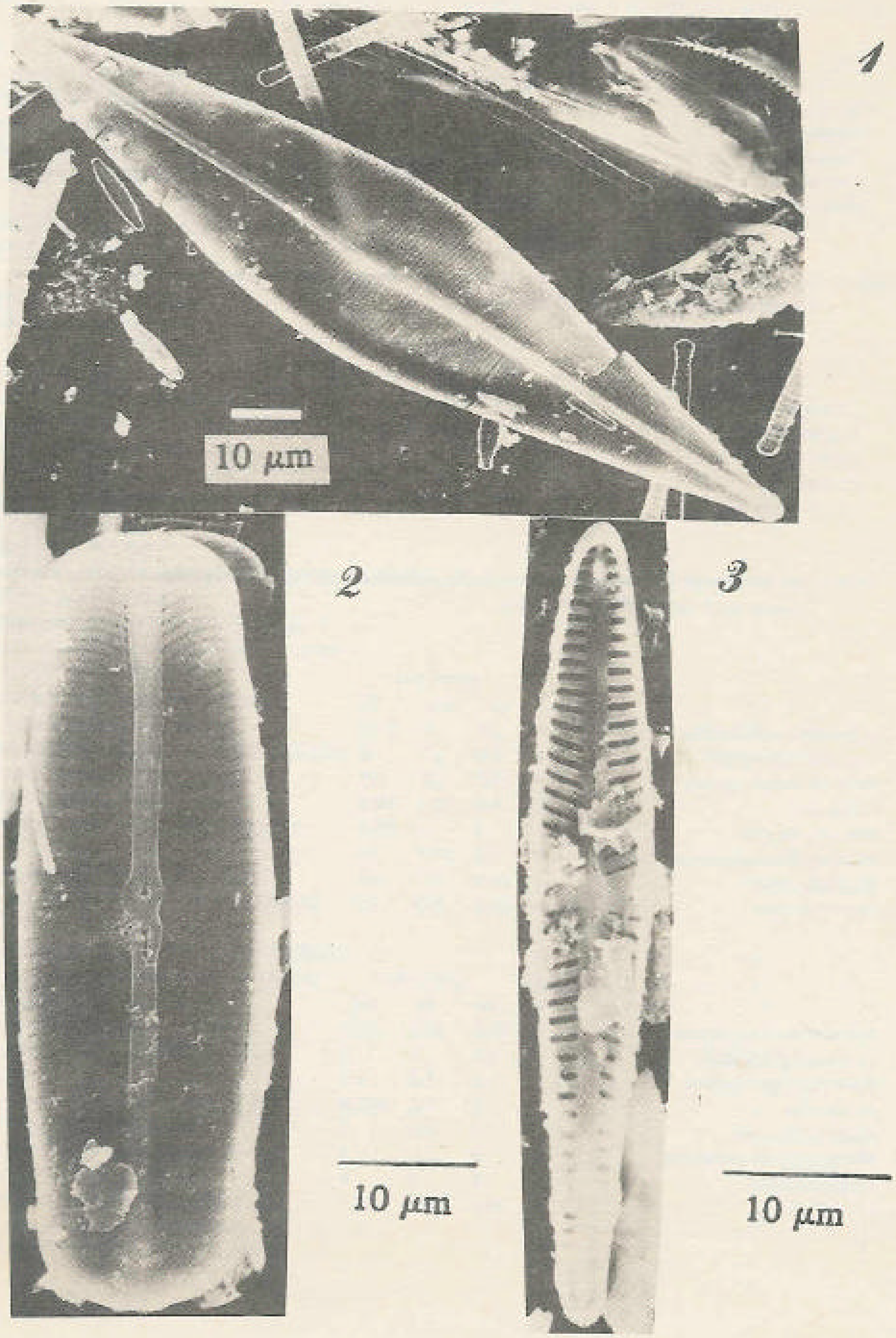

Plate I.
1 = *Navicula cuspidata*, 2 = *Navicula pupula*, 3 = *Gomphonema olivaceum* var. *calcareum*

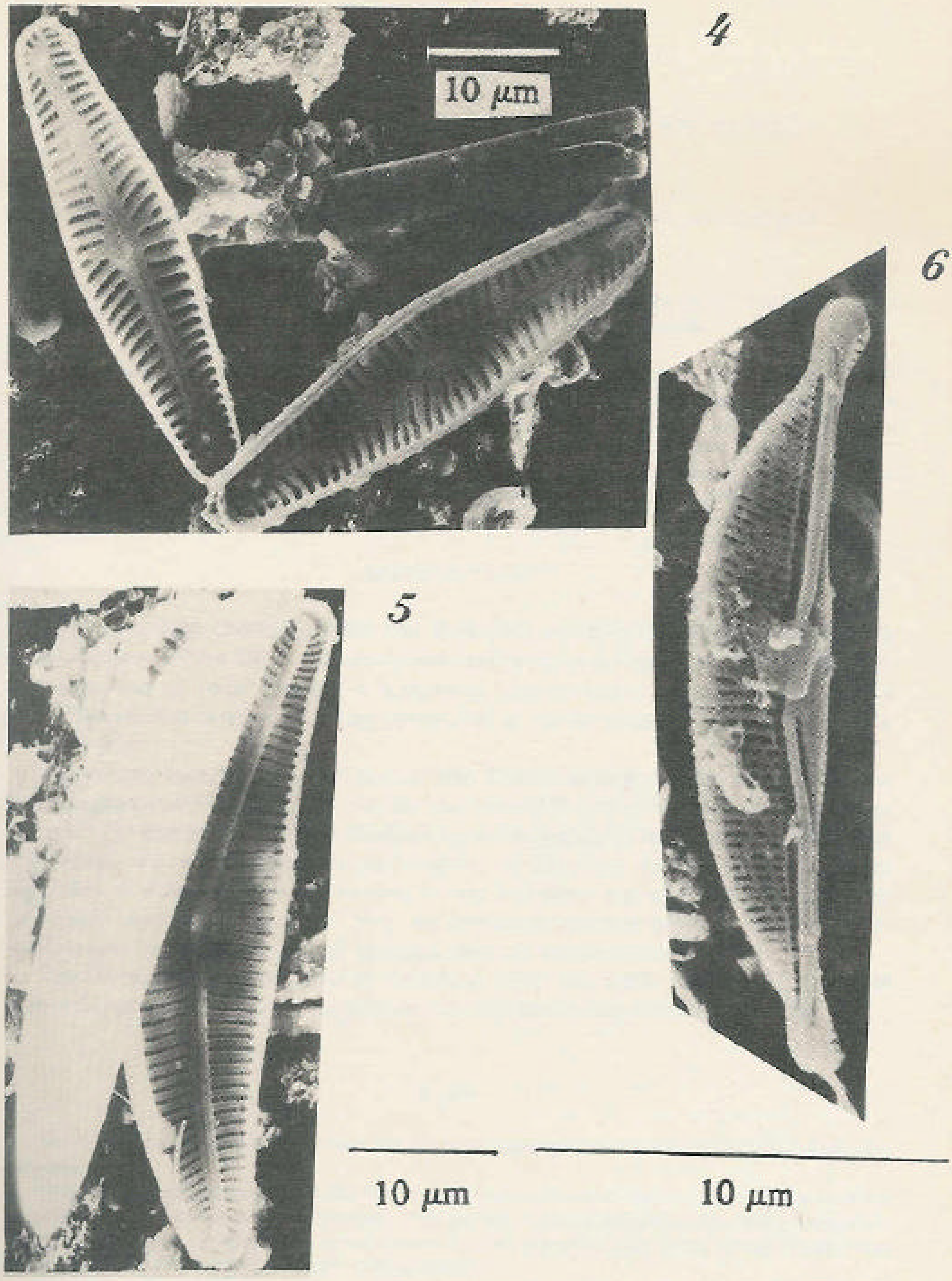

Plate II.
4 = *Cymbella lacustris*, 5 = *Cymbella affinis*, 6 = *Amphora coffeaeformis*